tumour, tie the axillary above and below the aneurism, if practicable, and hasten to bring about a healthy condition of the cavity occupied by the effused blood; and should the pressure of the aneurism have induced caries of the joint, and permanent injury to the axillary nerves, amputation at the articulation would then be required.

The accompanying figures from photographs (Figs. 3 and 4) give an accurate idea of the appearance of the stump when the patient was discharged from the hospital. Much more tissue covers the shoulder than was required, and gives the impression that the head of the bone is still in place, but it must be remembered that this was nature's flap, the irregularity of the line of union in front being the original tortuous line of demarcation.

Table of Subclavian Ligations which have occurred at Philadelphia.

No.	Operator.	Date.	Place of ligation.	Disease or injury.	Result.
		CIVIL HOSPITALS.			
1	Gibson,	1828.	3d portion.	Rupture of axillary.	Died.
2	Drayton,	1859.	" "	Rupture of axillary.	Died.
3	Morton,	1866.	2d "	Spontaneous aneurism.	Recovered.
		MILITARY HOSPITALS.			
1	Gross,		3d portion.	Gunshot wounds.	Died.
2	Coolidge,		" "	"	"
3	Hopkinson,		" "	"	"
4	Kennedy,		" "	"	"
5	Morton,		" "	"	"
6	Levis,		" "	"	Recovered.
7	Wells,		" "	"	Died.
8	Not stated,		" "	"	"

ART. VII.—*On Astigmatism, considered in its Relations to Defective Vision, Asthenopia, and Progressive Myopia.* By JOHN GREEN, M.D., of St. Louis, Mo.

IN a former paper (*Am. Journ. Med. Sciences,* January, 1867) I have briefly alluded to the very important disturbing influence of the accommodative act in astigmatism, as shown not only in complicating and masking the visual phenomena, but also in the production of asthenopia, and sometimes even of progressive myopia. I propose, now, to examine the subject somewhat more in detail, with especial reference to the correction of visual defects, and the prevention or treatment of other complications, beginning with the study of

Simple Positive Astigmatism (Am).—In this malformation, which may be considered as a partial myopia, the accommodative faculty is called into action in near vision only. In viewing distant objects, the eye instinctively abstains from accommodative efforts, which serve only to impair the distinctness of visual perception. A partial closure of the eyelids, however, by effectively converting the aperture of the pupil into a narrow slit, may materially assist in the recognition of distant objects, although at the expense of considerable loss of light. In near vision, any want of distinctness in the retinal image is in part compensated by bringing the object nearer, aided by the natural contraction of the pupil, and perhaps also, as in distant vision, by the partial closure of the lids. If moderate in degree ($\frac{1}{40}$ or less), and occurring in an eye otherwise healthy, this form of astigmatism is rarely attended with much inconvenience, and therefore most frequently escapes detection, or, if detected, demands only such occasional aid as is afforded in distant vision by a concave cylindrical eye-glass. In near vision also, so long as the accommodative power remains good, no especial inconvenience is felt; for any slight indistinctness in the definition of small objects, if not wholly overcome in the manner just mentioned, is still farther diminished and pretty effectually concealed by rapid and unconscious changes of accommodative tension, bringing the different features of the object succcessively under inspection. Asthenopia, if it occur at all, will only manifest itself in near vision in consequence of these unsteady and oscillatory accommodative efforts, and will generally be insignificant in degree. If the astigmatism exists in a higher degree ($\frac{1}{20}$ to $\frac{1}{10}$), serious asthenopia may be caused by the abnormal strain on the accommodation, especially as there is a strong temptation to hold the book or work even nearer to the eye than in myopia of the same grade. The strong accommodative exertion thus induced, together with the attendant increased efforts at convergence, may lead to muscular asthenopia, or may even prove a powerful exciting cause of myopia. The obvious remedy for these dangers and disabilities consists in the correction of the astigmatism by appropriate concave-cylindrical glasses, bearing always in mind that the higher the grade of the astigmatism the more accurately must the axis of each glass be adapted to the direction of the ocular meridian of least curvature. Such glasses suffice equally for distant and for near vision, so long as the range of accommodation continues tolerably good—that is, until the development, with advancing years, of actual presbyopia.

Attention has lately been called by Donders to the fact that presbyopia consists not only in the progressive limitation of the range of accommodation, but also in a sluggish, and, as it were, reluctant performance of such accommodative adjustment as is still possible. The adjustment, too, when once effected, continues for a little time after the voluntary effort and the convergence of the visual axes have ceased, and it is only after the lapse of some moments that the eye regains its former adjustment for distant vision. When, therefore, this condition of the accommodative faculty, which precedes by several years the ordinary recognition of presbyopia, has once developed itself, rapid changes of accommodative adjustment from one to the other of the two astigmatic foci become impossible. The consequence is that the eye no longer attempts to vary its adjustment for different features of near objects, but rests content with less perfect, but, at the same time, less fatiguing vision than at an earlier period of life. The eyes seem, therefore, to have become physically stronger, although optically less perfect; in other words, any asthenopia which may have previously existed, gives place to more or less defective vision at all distances. Convex glasses are perhaps now adopted with the advantage of magnifying near objects, but still without securing perfect definition. All objects, in fact, whether near or distant, both when viewed with the naked eye and with convex glasses, appear shaded, doubled, or indistinctly defined in the direction of one or the other of the principal meridians of ocular refraction. This may give rise to little or great inconvenience in reading common print, according as the principal meridians correspond more or less nearly to the horizontal and vertical direction, and so admit of the accurate adjustment of the eye for the vertical limbs of the letters, upon which their easy recognition chiefly depends. The whole visual defect is then thrown into the form of a shading or reduplication of the words in the blank space below the lines; and but little inconvenience is felt, provided only that the lines are sufficiently separated or "leaded"—(a similar shading or reduplication above the lines is, to a great extent, prevented by the natural drooping of the upper eyelid). Great difficulty may be experienced, however, in reading "solid" matter, in which the lines are crowded closely together, and any spherical glass which increases the distinctness of the lines is found to be worse than useless by impairing the distinctness of the letters. In this condition of the eye, very great benefit may often be derived from the employment of cylindrical glasses; and it will frequently be found that concave cylindrical glasses are sufficient even for reading, for it must be remembered that the visual defect has not yet reached the point of absolute presbyopic limitation of the range of accommodation, but consists rather in the loss of power of rapid adjustment.

With the further progress of presbyopia a new phenomenon is observed, viz., the change, in viewing near objects, of the meridian of most distinct vision, dependent on the recession of the farther of the two near points beyond a convenient reading distance. So long as the accommodative power of the eye remains tolerably good, the eye makes strong efforts to adjust itself in near vision for the same meridian as in distant vision. This, in the case now under consideration, is always the meridian of least ocular refraction, and it is only after this adjustment has become impossible, owing to increasing presbyopic limitation of the range of accommodation, that the eye falls back upon the easier adjustment for the meridian of greatest curvature. This inversion of the meridians of clearest near and distant vision, as shown by the inspection of proper test-diagrams, is very striking and characteristic. Its effect, too, in impairing the usefulness of the eye in reading may be very great, if, as is oftenest the case, the change is from the adjustment for vertical to that for horizontal lines. Under these circumstances there may be such confusion in the letters as to render them quite illegible, although the lines may still appear perfectly distinct. This form of astigmatic presbyopia may come on quite suddenly, especially if from temporary disuse of the eyes—as in sickness—the accommodative power has become enfeebled, and the initial degree of this presbyopia will generally be equal to the whole degree of the astigmatism. Such a case of presbyopia, although perhaps quite sudden in its access, may, however, continue for a long time without sensible increase, for the eye has now a new store of accommodative power in reserve equal in amount to the full degree of the astigmatism. The treatment of this form of presbyopia should be begun by the use of convex cylindrical glasses carefully adjusted to correct the whole degree of the astigmatism; if concave cylindrical glasses have been previously worn, they may be changed for the corresponding convex glasses with the direction of the axes reversed. Should, however, the degree of the astigmatism be very high, the transition from concave to convex cylindrical glasses, or the adoption of the latter in the early treatment of the presbyopia, may involve the production of an unnecessary and inconvenient degree of artificial myopia. In such a case a special glass may be ordered, in which this tendency is overcome either by the combination of a convex and a concave cylindrical surface with their axes turned to a right angle to each other, or, as is more generally advised, by combining a convex cylindrical surface adjusted to correct the astigmatism with a concave spherical surface adapted to correct the excessive artificial myopia. Whenever in the progress of the presbyopia it comes to exceed the degree of the astigmatism, the simple cylindrical glass ceases to afford the requisite correction; it then becomes necessary to reinforce it by the addition of a convex spherical surface of suitable focus. The same result may be attained also by combining two convex cylindrical surfaces, of different radii, with crossed axes.

Simple positive astigmatism is very frequently mistaken for ordinary myopia, and treated by common concave glasses. This is, I believe, a frequent and important source of danger to the eye. A person labouring under this form of astigmatism discovers that his general perception of distant objects is inferior to that of his friends, and is led to make trial of concave spectacles. The effect of these glasses, if not too strong, is to change the region of accommodation so that the eye when at rest is now adjusted in distant vision for the meridian in which it was before myopic, while by a certain accommodative effort the adjustment can be readily changed to the other meridian. The total perceptive power of the eye may thus be very sensibly increased, but at the cost of incessantly varying accommodative efforts. The result is, frequently, such a degree of asthenopia as to lead to the speedy rejection of the glasses; but, unfortunately, this admonition is not always heeded, and so more serious complications may arise. One of the first results of the adoption of concave spectacles in this form of astigmatism is the neglect of the habit of complete accommodative relaxation in distant vision, as is shown by the eye soon relapsing into the habit of accommodating for its meridian of least refraction, so that the glasses seem to have lost their original efficacy; meanwhile it is discovered that without the glasses distant vision has become less distinct than it was before their adoption, and that their use has given rise to an apparent myopia. Thus far no great harm has been done; and if the glasses are now abandoned, the eye gradually returns to its original condition. It too often happens, however, that the apparent myopia thus induced is interpreted as an indication for stronger glasses; these, in turn, are soon outgrown, and are exchanged for still stronger, until actual and perhaps rapidly progressive myopia is developed. This tendency to the production of myopia is increased by the fact that the apparent size of objects is diminished by the concave glasses, and so the necessity for holding the book near the eye in reading becomes greater than before. This, in turn, calls for increased efforts of accommodation to overcome the effect of the concave glasses, and of convergence to reinforce the overtaxed accommodation.

When, with advancing years, the disability of presbyopia has been superadded to that of astigmatism, it is often possible, by a few trials with common convex spectacles, to find a pair which suffices tolerably for reading, by so correcting one eye or both as to throw the whole visual defect into the form of a shading or reduplication of the words in the spaces between the lines. This amounts, in fact, to the restoration of about the same reading power as the person has been accustomed to, and is therefore generally accepted as a satisfactory result. With such imperfect correction, however, the resultant acuteness of vision may still be far below the normal standard; this may lead to the habit of using very strong glasses, in order to increase the apparent diameter of small objects by bringing them very near to the eye. This calls, of course, for excessive convergence of the visual axes, and may lead either to muscular asthenopia or to the abandonment of the habit of binocular vision. The obvious remedy for these disadvantages is in the adoption of convex cylindrical or spherico-cylindrical glasses.

In the foregoing remarks but little notice has been taken of variations in the direction of the meridians of greatest and least refraction. It may be readily conceived, however, that the direction of these meridians, with reference to the dominant lines of surrounding objects, must very greatly affect the usefulness of the eyes for particular kinds of work. How this is shown in reading has been already noticed. In the common walks of life, also, both within doors and out of doors, the great majority of the regular objects of which the eye takes especial cognizance are defined by vertical and horizontal lines. Such are the architectural and structural lines of buildings, the lines of the letters upon sign-boards and placards, the line of the distant horizon, the trunks of trees, &c. If now, in a case of positive astigmatism, the principal meridians of the eye correspond pretty nearly in direction to the horizontal and vertical, lines lying in one or the other of these planes will appear clearly defined, while those lying in all other planes, and especially in the opposite plane, will be more or less indistinct. Such a correspondence of the principal meridians of the eye with the dominant lines of surrounding objects is, however, by no means constant; in fact, it may be considered the exception rather than the rule. In investigating any considerable number of cases with reference to the direction of the principal meridians in the two eyes, it will be found that they fall naturally into two distinct classes, viz., the symmetrical and the unsymmetrical. Of the symmetrical cases many will be found in which the corresponding meridians vary but little from the vertical, in which case the two retinal images will be nearly identical, and the two eyes will work well together and give substantially the same visual result as either eye singly. If, on the contrary, the combined deviation in the two eyes is equal to ninety degrees, both vertical and horizontal lines will appear indistinct; but oblique lines lying in the two planes midway between the vertical and horizontal will be pretty clearly defined, and by covering first one eye and then the other, it will be evident that this is the result of the combined impression, upon the sensorium, of two dissimilar retinal images. So, too, if with the direction of the principal meridians absolutely identical in the two eyes, there happens to be also a refractive difference equal or about equal in degree to the astigmatism, it will be found that with any given degree of accommodative effort the two eyes will be adjusted at equal distances for the two opposite meridians, which will be oftenest the vertical and horizontal, and so the astigmatism may wholly escape detection by the ordinary tests of horizontal and vertical lines. Of the unsymmetrical cases a certain number present a nearly equal deviation in the same direction, and so admit of identical images in the two eyes, but with the plane of most distinct vision inclined to the vertical. This may lead to a habit of bending the neck to one side or the other in looking at vertical or horizontal lines, or of giving to the book or paper an oblique position in reading or writing. With unequal deviation in the two eyes there will be two planes of most distinct vision intersecting each other at an angle equal to the sum or to the difference of inclination.

When the retinal images in the two eyes are materially different, the visual phenomena may be variously modified. Objects with strongly dominant lines, corresponding in direction to the two meridians of most distinct perception, have often a peculiar glittering appearance, owing to the mind taking especial cognizance first of one retinal image and then of the other in rapid alternation. Other objects, with outlines less conspicuously marked, may present no details of sufficient prominence to fix the attention, and so appear generally indistinct. When one eye is astigmatic while the other is of normal visual acuteness, the distorted astigmatic image becomes a source of confusion; it may, therefore, come to be wholly neglected in ordinary vision, or, if the astigmatism is of a low grade, it may prove to be only an occasional inconvenience, and is then, perhaps, temporarily excluded by the closure of the eye.

Positive Astigmatism with Myopia (M+Am).—The cöexistence of astigmatism with myopia is much more frequent than has been generally supposed; in fact, in cases of decided myopia the absence of astigmatism appears to be the exception rather than the rule. The astigmatism, even when considerable in degree, is in unaided vision so masked as generally to escape detection, while the improved perception of distant objects with concave glasses often leads to the hasty conclusion that there can be no remaining defect worth investigating. Concave glasses when used are almost always chosen of excessive strength, so as to convert the case into one of negative astigmatism (Ah) or even of negative astigmatism with hypermetropia (H+Ah). This artificial change in the region of accommodation enables the eye to adapt itself to the reception of parallel rays lying in the plane of either of its principal meridians, and so the characteristic phenomena of astigmatic vision are hidden in a mass of seemingly contradictory observations. The improved visual power at a distance acts as a perpetual incentive to accommodative efforts, which are attended at first with more or less of asthenopia, but which, later in life, are performed sluggishly and with difficulty; this gives rise to a comparative slowness of perception, which, in time, gradually increases, until, with advancing years, accommodative adjustments are finally abandoned, and the eye finds rest in amblyopic vision.

In near vision, and especially in reading, the astigmatic eye is compelled to distinguish objects whose size has generally been fixed with reference to the powers of normal eyes. It follows, therefore, that, in astigmatism as in hypermetropia, the eye attempts to make up for the indistinctness of small objects by bringing them nearer the eye and thus enlarging their retinal images. This calls for increased efforts at accommodation and convergence, with their attendant disabilities and dangers. These are: 1st. Muscular asthenopia and insufficiency of the internal recti muscles as the result of the excessive convergence; 2dly. Ordinary asthenopia from the strong accommodative efforts provoked by the attempt to read at too short distances; 3dly. The form of asthenopia which occurs also in distant vision with concave glasses, and which here depends upon continually changing accommodative efforts called forth by the necessity for more distinct perception of a doubtful letter or figure; and 4thly, as the direct consequence of the excessive and long continued strain, myopia from posterior distension of the eyeball. When myopia is superadded to astigmatism the temptation to hold the book very near the eye is much stronger than in simple astigmatism, while the dangers which attend the habit remain undiminished and thus the myopia may become progressive.

The progressive tendency of the myopia, although it often goes on to a most alarming extent, is yet restrained by some opposing agencies. Thus the muscular asthenopia may compel the sufferer to desist from pursuits for which his eyes are unsuited; or this may give place to insufficiency of the internal recti muscles which may terminate in intermittent or permanent external strabismus, and so the efforts at convergence having become unavailing, cease to be made. Or the increasing myopia may finally lead to the use of concave glasses so strong that the astigmatism may be accidentally corrected in one eye or both by giving a peculiar twist to the spectacle frame or by looking obliquely through the glasses. The asthenopia which is felt in viewing distant objects through strong concave glasses gradually gives way, too, with advancing years, owing to the more sluggish manner in which the accommodative act is performed by the harder crystalline, rendering it impossible successively to accommodate for the different meridians without too great expenditure of time.

The treatment of positive astigmatism combined with myopia must be first and chiefly by concave cylindrical glasses, which must be carefully adapted to correct the exact degree of astigmatism in both eyes. If the degree of myopia remaining is still such as to make it necessary in reading to hold the book too near the face, a concave spherical surface must be added; but it is not well to be hasty in deciding upon the necessity for this additional aid, for it often happens that, from previous abuse of concave glasses, the eye has in part lost the habit of accommodative relaxation, and requires time for its recovery. For distant vision it is necessary to measure and correct the total refractive anomaly, bearing always in mind that, from the cause just mentioned, the degree of the myopia may appear to be greater than it really is. If simple cylindrical glasses suffice for reading and for near vision, it may be well to prescribe for distant sight an ordinary concave eye-glass to be used in connection with the cylindrical spectacles. Above all must we beware of the dangers which attend the use of common concave glasses. The mischief they may do in rendering distant vision fatiguing and painful has been already noticed, while in reading they can obviously be of no use, for the habit of holding the book near to the eyes depends, not upon extreme myopic change in the position of the far point of distinct vision, but upon the effort to compensate for the indistinctness of the retinal images by increasing their size.

The important practical lesson to be drawn from these considerations is that *myopia is a complex and important disease* whose successful treatment demands an accurate knowledge of the physiology of vision as well as the exercise of much patience and the employment of improved methods of examination.

The treatment of myopia with astigmatism in the later years of life, after the development of full presbyopic limitation of the range of accommodation, must depend entirely upon the position of the far and near points of distinct vision. For distant vision substantially the same glasses will be needed as at an earlier period, while for reading, choice must be made between concave and convex cylindrical glasses, either simple or combined with convex or concave spherical surfaces. In general, such glasses should be selected for reading as completely correct the astigmatism, and, at the same time, leave the near point as close to the eye as is consistent with easy convergence of the visual axes.

Simple Negative Astigmatism (Ah).—In this form of astigmatism it is within the power of the eye, by changes of adjustment, to bring to a focus parallel rays, lying in the plane of either of its principal meridians. Hence it is seldom the case that in distant vision any great difference is perceived in the distinctness of lines situated in different planes, for the eye forms the habit of unconsciously varying its adjustment to suit the direction of the particular lines to which its attention is directed. Tested by Snellen's types, the acuteness of vision may seem to be nearly or quite normal, but it will always be found that in looking at objects of more complex design, the finer details appear confused. So also in near vision, it will be found that large and well-printed letters are clearly recognized, but that the smaller types, especially in badly printed books, can only be distinguished by bringing them rather near to the eye. Hence may arise, in distant vision, asthenopia from the necessity for constantly varying accommodative adjustments, and, in near vision, muscular asthenopia with perhaps insufficiency of the internal recti muscles or even divergent strabismus, all dependent on the excessive efforts at convergence of the visual axes. Myopia is not generally to be feared, for the very fact of the eye remaining hypermetropic, or negatively astigmatic, in the presence of powerful exciting causes, is evidence of the absence of predisposition to that disease. The disabilities which attend negative astigmatism are therefore of the nature of asthenopia, with more or less defective vision. As accommodative adjustments become sluggish with advancing years, the asthenopia in distant vision gives place to less perfect visual perception. Presbyopia, too, is developed by as much earlier than usual, as the refractive power of the eye is originally weaker in its meridian of least curvature. The comparative difficulty of distinguishing small type leads to the early adoption of convex glasses, and generally to the selection of a strong pair, in order to secure the advantage of large retinal images, by allowing the book to be held near to the eye.

The habit of holding the book near the eyes in reading sometimes leads to an erroneous diagnosis of myopia, and the adoption of concave glasses. These, of course, are of no real advantage, yet it is sometimes the case that they are worn under the impression that they are the proper thing, and that somehow they must be of service.

The treatment of negative astigmatism is by convex cylindrical glasses. These serve equally for distant and near vision so long as the eye retains a sufficient accommodative range. With the development of presbyopia arises the necessity for additional aid in reading, which may be given either by special glasses, ground with a cylindrical curve on one side and a spherical curve on the other, or by a convex eye-glass used in front of the cylindrical spectacles.

To detect and measure negative astigmatism, or negative astigmatism with hypermetropia, they must first be converted into positive astigmatism by placing an appropriate convex lens before the eye.

Negative Astigmatism with Hypermetropia (H+Ah).—The symptoms of negative astigmatism with hypermetropia, as of simple negative astigmatism, take chiefly the form of asthenopia, the visual defect being more or less completely masked by accommodative efforts. In reading there is the same degree of indistinctness of the retinal images as in simple astigmatism, but it often happens that the degree of hypermetropia is such as to neutralize any advantage from bringing the book nearer to the eye, and so the case is less likely to be mistaken for myopia. The asthenopia, too, is of the kind dependent on excessive or changing accommodative efforts, and strabismus, if it occurs, is likely to be of the convergent variety. Myopia, if it could be artificially induced, would be, to a certain extent, curative, but, unfortunately perhaps, the predisposition is wanting. Presbyopic vision may be developed very early in life, and in exceptional cases may even exist from the beginning.

Persons with negative astigmatism and negative astigmatism with hypermetropia apply for aid on account either of asthenopia or defective vision. The asthenopic symptoms seem frequently to be explained by the discovery of a certain degree of hypermetropia, but the correction of the hypermetropia by common convex glasses often fails to afford the full measure of relief expected. Much benefit may, however, follow their use from the conversion of the negative astigmatism or negative astigmatism with hypermetropia into positive astigmatism, in which case accommodative efforts cease to be useful in improving distant vision and are therefore soon abandoned. The relief is however but imperfect even in distant vision, for the disadvantage of ill-defined retinal images still remains in part or wholly, while in reading it may happen that the correction of the hypermetropia takes away the former safeguard against holding the book too near the eyes and so opens the way for the development of muscular asthenopia.

The treatment of negative astigmatism with hypermetropia should, I think, consist, 1st, in the correction of the astigmatism by convex cylindrical glasses; and 2dly, in the correction of the remaining hypermetropia if of a sufficiently high grade to make it worth the while to treat it. The principles which must regulate the treatment of presbyopia, when it appears, have been already sufficiently explained.

Mixed Astigmatism (Ahm or Amh).—In this form of astigmatism, in which the eye is myopic in one meridian and hypermetropic in the other, it will often suffice to prescribe a concave cylindrical glass equal in power to the full measure of the astigmatism, so as to convert the case into one of simple hypermetropia. Later in life, when presbyopia has appeared, this glass must be exchanged in near vision for the corresponding convex cylindrical glass, reinforced if necessary by an appropriate spherical surface. Should the degree of astigmatism be very great, the use of simple concave or convex cylindrical glasses may involve the production of an inconveniently high grade of hypermetropia or myopia, in which case an appropriate spherical surface may be added. In measuring mixed astigmatism it is necessary to eliminate accommodative interference by the use of a convex lens.

In certain cases of asthenopia occurring in connection with astigmatism, and chiefly as I believe in that form of asthenopia which I have described as dependent on the state of accommodative unrest incident to incessant changes of accommodative tension, the eye sometimes manifests such a degree of irritability as to induce almost spasmodic efforts at accommodation whenever the visual act is attempted. In such cases it may be necessary temporarily to paralyze the accommodative organs by atropia before attempting to measure the state of the refraction, and even after fitting the eyes with the most accurately adjusted glasses the spasmodic efforts at accommodation may persist to such a degree as seemingly to render the optical corrective fruitless. The special indication for treatment in this state of things is clearly to maintain, by the continued use of atropia, such a degree of accommodative paralysis as shall suffice to restrain all accommodative efforts until such time as the long continued disuse shall have overcome the tendency to spasm, supplying, of course, the temporary loss of accommodative power by such a pair of convex glasses as shall admit of the convenient use of the eyes in reading. Such a course has been pursued with striking success by Donders in several cases of obstinate asthenopia, in which, however, the existence of astigmatism is not mentioned. (See Donders, *On the Anomalies of Accommodation and Refraction of the Eye.* New Sydenham Society, London, 1864, pp. 625 and 626, also p. 289.)

In conclusion, the influence of astigmatism as a disturbing element in vision, and secondarily, as an exciting cause of disability or disease, may be thus briefly summed up:—

(*a.*) *Impaired visual acuteness* which (except in Am and M+Am, in distant vision) is masked, and to a certain extent overcome, by rapidly varying accommodative adjustments; the extraordinary exertions thus induced may be attended with unusual fatigue, and so give rise to a form of asthenopia which may be designated as

(*b.*) *Asthenopia from accommodative unrest.*—The impaired visual acuteness may lead in near vision to the habit of bringing small objects very near to the eyes in order to increase the size of their retinal images; hence a call for increased accommodative tension which (except in high grades of M with Am), may give rise to

(*c.*) *Asthenopia from excessive accommodative tension;* or, instead of asthenopia, the excessive accommodative tension, aided by increased convergent efforts may lead, in cases of *H+Ah* to the gradual development of

(*d.*) *Convergent strabismus.*—The excessive convergence of the visual axes necessitated by the habit of holding small objects very near to the eyes (especially in Am+M+Am), may lead to fatigue of the internal recti muscles or

(*e.*) *Muscular asthenopia;* which, by a continuance of the same habit, may take the form of

(*f.*) *Insufficiency of the internal recti muscles,* or even become developed into

(*g.*) *Divergent strabismus.*—Finally, the increased tension of the eyeball consequent upon these excessive efforts of accommodation and convergence must tend, in the presence of a certain myopic predisposition, both to excite and to aggravate

(*h.*) *Progressive myopia.*

These various disabilities may, for the most part, be overcome by the intelligent employment of cylindrical or spherico-cylindrical glasses. In certain cases of asthenopia (*b* and *c*) it may be necessary for a time to restrain unconscious accommodative efforts by the judicious use of atropia, or to train the accommodative organs by carefully regulated exercise. In cases of strabismus and of insufficiency of the internal recti muscles (*d*, *f*, and *g*) and sometimes also in muscular asthenopia (*e*) tenotomy may be indicated. In other cases of muscular asthenopia, by the employment of prismatic glasses with surfaces ground to appropriate cylindrical or spherical and cylindrical curves, we may be able to dispense with the surgical operation, and, by gradually exchanging the prisms for others of less deviation, we may succeed in training the internal recti muscles by exercise until the aid of the prisms may be altogether dispensed with. It would seem, also, that prisms must sometimes prove most valuable auxiliaries in combating the progressive tendency in myopia, especially where the acuteness of vision is somewhat less than normal, and where the temptation is consequently strong to hold the book very near to the eyes.

One additional point in the treatment of astigmatism by glasses demands a brief notice; that is, the equalization, as far as it is possible, of the two eyes. In the higher grades of astigmatism, although by the use of cylindrical or spherico-cylindrical glasses we may wholly correct the ametropia in every meridian, there still remains the great defect of distorted retinal images. Thus, a circle appears as an ellipse, etc. If the degree of the astigmatism and the direction of the principal meridians happen pretty nearly to coincide in the two eyes, this distortion is of little importance, and soon comes to be correctly estimated by the judgment. If, however, the astigmatism is confined to one eye, or if the direction of the principal meridians differs much in the two eyes, it is then impossible to provide for equal vision except by combinations of cylindrical glasses analogous to the Galilean telescope, which is obviously impracticable in ordinary cases. When, however, there is but slight irregularity in the two eyes, very great advantage may attend the exact correction of each, so as to admit of accurate binocular vision. This is effected by testing the two eyes at the same time by means of trial spectacles which have been previously fitted to each eye singly. By this test it will often be found that, owing to the disturbing influence of unconscious accommodative acts, the glasses thus selected, although seemingly well adapted to each eye singly, do not answer so well when used together. By covering rapidly first one eye and then the other, while both are directed towards a fixed object, it will be found that the adjustment of one is better than that of the other, and that the binocular result may be much improved by a slight change in the power of one or the other of the glasses, or possibly of both. When once the two eyes have been thus equalized, the existence of any remaining ametropia may be tested by the addition of a trial eye-glass containing a pair of very weak convex or concave glasses, and so the exact combination best adapted for binocular vision may be determined.

Proceeding in this way, it often happens that the rather complex combinations thus selected may be reduced to a simple cylindrical lens by neglecting insignificant quantities. This, when practicable, is a great advantage, for it enables us to prescribe at once a cylindrical glass which can be furnished by the optician from his stock, whereas the selection of a spherico-cylindric glass involves the necessary delay and expense attending the manufacture of a special glass for each case. Frequently, too, we may select simple cylindrical glasses either for reading or for distant vision, and give a common eye-glass, either concave or convex, to be used in connection with the spectacles in distant vision or in reading.

ST. LOUIS, January, 1867.